

possibilities of the case, as near as I can compute them, are as follows, taking the flood of 1897 as the maximum condition, and the danger line of 45 feet at Vicksburg as the line above which the water would begin to run off into the canal. At the time of the maximum stage of 52.3 feet the discharge in cubic feet per second was about 1,600,000, while at the 45-foot stage it was about 1,300,000. The difference of 300,000 feet is the quantity which it is desired to dispose of through the proposed canal. Assuming the velocity of the current to be 4 miles per hour, which is equivalent to 5.87 feet per second, the cross section of the canal would have to be  $300,000 \div 5.87 = 51,107$  square feet. Therefore, if the depth were to be 30 feet, the width would have to be  $51,107 \div 30 = 1,703.6$  feet, and its length would be about 12 miles. Both banks would need protection by revetments to secure permanency. I can give no close estimate of the cost of such a work, but I think it could be done for \$20,000,000 or less. On paper it certainly appears feasible. Opponents of the canal argue that it would gradually fill up by deposits of sand, but this objection is met by the reply that it applies equally to any portion of the river, and the canal, owing to its comparatively limited extent, could be effectually dredged to the required depth whenever necessary.

Above the mouth of the Missouri attempt has been made to lessen the flood heights by building storage reservoirs at the head waters. Five of these reservoirs were built, with a view to store surplus waters, which should be available for purposes of navigation when the low-water season set in. These anticipations were not realized, however. The floods were repressed to some extent as far as Lake Pepin, but not below, and as much as 1 foot of additional water was available at the low-water season at St. Paul, disappearing by the time Redwing, Minn., 52 miles below, was reached. In any event, with or without reservoirs, no floods north of Lake Pepin are felt to the southward to any considerable extent.

The effect in the lower river of an all levee system upon navigation would be to narrow the channel and, consequently, increase the velocity of flow during high water, thereby retarding somewhat the upstream movement of boats. Relief would come quicker, however, owing to the greater velocity of the water, as it would, of course, run off sooner. In times of low water it is probable that, there being no overflow or back water to run into the main stream and the levees causing a greater velocity in the flow of the water already there, the low-water season would be prolonged and still lower stages prevail than had obtained in the past. This would be impossible with the storage reservoir, as the surplus water could be let into the river just as needed.

This completes about all I have to say upon this subject, and I beg of you to bear in mind that I do not come here as an expert in these matters; I simply present to you the facts as I have gathered them in various ways. The subject is certainly one of deepest importance, and justifies almost any expenditure of time and money to produce satisfactory results. The proper improvement of the Mississippi River may require thirty or forty years of time and may cost \$300,000,000. It could probably be done in one-half the time and for one-half the money or less. But no matter what the cost, the moral, social, and economic development of many millions of people is directly concerned, and it is not always wise to too closely reckon the cost in mere dollars and cents.

#### SMALL WHIRLING COLUMNS OF MIST.

By RALPH B. MAREAN, Weather Bureau, dated October 25, 1899.

On Sunday, October 22, a very interesting meteorological phenomenon was observed by me at the upper or receiving reservoir on the Conduit road a few miles above Washington. It was about 7:30 of a perfectly clear, calm, frosty morning.

Over the mirror-like surface of the pond hung a ragged mist from 5 to 10 feet deep and so thin that it did not obscure objects on the opposite shore, some three hundred yards distant. When first seen there was no perceptible movement in this veil of mist; it rested almost motionless on the surface of the lake. Soon, however, it was noticed that it had begun to drift hither and thither in all directions. In two places within 50 or 100 feet of each other the movement would be in opposite directions. Almost simultaneously with the beginning of this movement of the fog there appeared whirls or spouts in the mist, seeming to form where two nearly opposite currents of air met, as shown by the drifting mist. Some of the columns were evidently formed as rolls between two parallel opposed currents. When first formed these spouts were from 2 to 4 feet in diameter, extending but 2 or 3 feet above the surface of the water and rotated (counter clockwise) but five or six times per minute. The speed of rotation rapidly increased, however, until at the end of half a minute or so it would be about thirty or forty per minute, the diameter decreasing at the same time to from 6 to 18 inches, while the column grew until about 20 feet in height. The column appeared hollow, the denser mist being in the outer ring. In the fully developed whirls there was a well defined upward spiral motion, the angle of ascent being, as nearly as could be judged, between 45° and 60° with the horizontal. Although some of these spouts lasted probably as long as five or six minutes, their average life was about two minutes, but within the twenty or twenty-five minutes during which the phenomenon was observed a great many, probably over a hundred, of these little whirling columns of mist were seen. Generally they had no progressive motion, although a few wandered aimlessly here and there. Gradually the number of the spouts diminished and finally in about half an hour no more were formed, the mist in the mean time having become almost entirely dissipated, partly by the rising sun and partly by the mixture of dry air.

Of course one could not witness a phenomenon of this kind without trying to discover its cause. It seems to the writer that the lower stratum of air had become heated by radiation from the comparatively warm water, but as no disturbing incident occurred it lay in the hollow over the lake in a state of unstable equilibrium. As soon as something happened, however, to disturb this equilibrium the cold overlying air began to fall and crowded up the warm, light stratum beneath.

The scene was one of great beauty. In the eight or ten acres of the lake in view there would be a great number of these miniature columns of mist standing in relief against the dark pines in the background and as erect as they.

#### ADDITIONAL OBSERVATIONS OF THE ST. KITTS, W. I., HURRICANE.<sup>1</sup>

By W. H. ALEXANDER, Observer.

About noon of Thursday, September 7, the wind changed from the northeast to the north, from which direction it blew steadily with an average velocity of 17 miles per hour until 2 a. m. of the 8th, when it began varying between north and northwest and increasing in force. About 5 a. m. it set in steadily from the northwest and continued from that direction until 1 p. m., when it began shifting to the west and increasing rapidly in force. From 1:45 to 3:40 p. m. the wind came from the west with an average velocity of about 36 miles per hour. At 3:40 p. m. it shifted to the southwest and soon reached verifying velocity. About 3:15 a. m. of the 9th, the wind began blowing from the south, and by noon it was coming steadily from that direction.

<sup>1</sup> From a second report by Mr. Alexander, we copy the following additional details, received too late to be inserted in the chapter on Forecasts and Warnings.